

What is claimed is:

1. A fuel cell comprising:

an anode;

a cathode;

5 a membrane that separates the anode and the cathode;

an electrolyte that holds water as a compound or in a coordinated state;

a carbon fuel.

2. The fuel cell of Claim 1, wherein the carbon comprises an activated carbon.

10 3. The fuel cell of Claim 1, wherein the carbon comprises carbon recovered from organic waste.

4. The fuel cell of Claim 1, wherein the anode is selected from the group consisting of catalytically-enhanced carbon, nickel metals and graphite.

15 5. The fuel cell of Claim 1, wherein the cathode is selected from the group consisting of stainless steel, catalytic carbon, porous nickel, oxygen-reacting cathodes, and graphite.

6. The fuel cell of Claim 1, wherein the membrane comprises at least one of a proton permeable membrane and a ceramic cloth.

20 7. The fuel cell of Claim 1, wherein the electrolyte comprises a chemical selected from the group consisting of an alkaline hydroxide and a hydrated alkaline earth chloride.

25 8. The fuel cell of Claim 1, wherein the electrolyte comprises a chemical selected from the group consisting of sodium hydroxide, potassium hydroxide, hydrated magnesium chloride, hydrated calcium chloride, hydrated strontium chloride, magnesium hydroxide, magnesium oxide, iron carbonate, manganese carbonate, cerium carbonate, and mixtures thereof.

9. The fuel cell of Claim 1, further comprising a regeneration cell coupled to the fuel cell wherein the regeneration cell comprises:

an anode;

30 a cathode;

an alkaline chloride electrolyte; and,

a membrane separating the anode and the cathode.

10. A regeneration cell comprising:
an anode;
a cathode;
an alkaline chloride electrolyte; and,
a membrane separating the anode and the cathode.

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11. The regeneration cell of Claim 10, wherein the anode is selected from the group consisting of coated titanium and catalyzed carbon.

12. The regeneration cell of Claim 10, wherein the membrane is a proton-permeable membrane.

10 13. The regeneration cell of Claim 10, wherein the alkaline chloride electrolyte comprises a chemical selected from the group consisting of sodium chloride and potassium chloride.

15 14. The regeneration cell of Claim 10, wherein the anode and the cathode comprise a bipolar array formed from a single graphite carbon electrode having two sides wherein a first side is the anode and a second side is the cathode.

16 15. A method of producing hydrogen comprising contacting carbon with water in the absence of oxygen, in a fuel cell comprising:

20 an anode;
a cathode;
an alkaline hydroxide electrolyte; and,
a membrane separating the anode and the cathode,
wherein, an alkaline carbonate is formed at the anode and hydrogen gas is formed at the cathode.

25 16. The method of Claim 15, wherein the carbon is at least one of activated carbon and carbon recovered from organic waste.

17. The method of Claim 15, wherein the alkaline hydroxide is selected from the group consisting of sodium hydroxide, potassium hydroxide and mixtures thereof.

18. A method of forming carbon dioxide comprising contacting carbon with water in the presence of a carbonate and oxygen in a fuel cell comprising:

30 an anode;
a cathode;
an electrolyte; and,

a membrane separating the anode and the cathode,
wherein, carbon dioxide is generated at the anode and the carbonate is formed at the cathode.

19. The method of Claim 18, wherein the carbonate is selected from the group
5 consisting of magnesium carbonate, iron carbonate, manganese carbonate and cerium carbonate.

20. The method of Claim 18, wherein at least one of the anode and the cathode comprises a nickel metal.

21. A method of forming carbon dioxide comprising
10 contacting carbon dioxide with at least one of magnesium hydroxide and magnesium oxide to form a bicarbonate; and,
contacting the bicarbonate with a carbon to form carbon dioxide,
wherein the step of contacting a bicarbonate with a carbon is conducted in a fuel cell comprising:

15 an anode;
a cathode;
an electrolyte; and,
a membrane separating the anode from the cathode,
wherein the magnesium carbonate is formed at the cathode.

22. The method of Claim 21, comprising the additional step of adding water to
20 the at least one of magnesium hydroxide and magnesium oxide before contacting the carbon dioxide.

23. The method of Claim 21, wherein at least one of the anode and the cathode comprise a nickel metal.

24. The method of Claim 21, wherein the carbon comprises carbon recovered
25 from organic waste.

25. The method of Claim 21, wherein the electrolyte is selected from the group
consisting of an alkaline hydroxide, an alkaline metal hydrate and combinations thereof.

26. A method of producing hydrogen comprising contacting an alkaline hydroxide
30 with carbon in the presence of carbon dioxide and water, in a fuel cell comprising:
an anode;
a cathode; and,

a membrane separating the anode and the cathode,
wherein, a carbonate is formed at the anode and hydrogen gas is formed at the cathode.

27. The method of claim 26, wherein the alkaline hydroxide is at least one of
5 sodium hydroxide and potassium hydroxide.

28. The method of claim 26, wherein the carbon comprises at least one of
activated carbon and carbon recovered from organic waste.